CHAROPHYTA FROM BABYLON (REPUBLIC OF IRAQ)

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ABSTRACT - This paper is a contribution to investigation of charophytes of Iraq, collected from three localities on the territory of the ancient town of Babylon.

Five species are identified: *Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *Chara gymnophylla* A. Br. and *Chara contraria* A. Br. ex Kütz. Morphological explanation, size of oogonia, antheridia and oospores as well as data on localities and geographical distribution are given for each of them according to the literature and author's observations. Ecological spectra of those species are supplemented with data on temperature and pH reaction of the water. All investigated species appear to tolerate a wider range of pH values towards more alkaline water (up to 8.5) than it is recorded in the literature, whereby *Nitella opaca* seems to have the widest range of pH tolerance. Three of them *(Nitella opaca, Tolypella glomerata* and *Chara contraria)* show more tolerance for high water temperature (up to 29.5°C) than it was more mentioned in literature.

RÉSUMÉ - Cette étude présente les résultats des recherches effectuées sur les Characées de la République d'Irak. Les spécimens ont été récoltés dans trois localités du territoire de l'ancienne cité de Babylone. Cinq espèces ont été déterminées: *Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *C. gymnophylla* A. Br. and *C. contraria* A. Br. ex Kütz. La description morphologique de chaque espèce est accompagnée de la mesure des oogones, des oospores et des anthéridies, de la température et du pH de l'eau de la station, de la répartition géographique basée sur la littérature et les observations. Toutes les espèces manifestent une tolérance plus élevée du pH de l'eau par rapport à celui antérieurement publié; le spectre le plus large est observé chez *Nitella opaca*. Trois d'entre elles *(Nitella opaca, Tolypella glomerata* et *Chara contraria)* présentent une plus grande tolérance aux températures élevées (jusqu'à 29°5C) que celle jusqu'ici indiquée dans la littérature. (Résumé revu par la rédaction).

INTRODUCTION

First data on Iraqi algae are given by Ehrenberg (1844). A hundred years later, freshwater algae from Mesopotamia and Kurdistan have been investigated by Kolbe and Krieger (1942). Different papers on phytoplancton of lower stream of the rivers Tigris and Euphrates, Shatt al-

Arab channels and other freshwater biotops as well as on algal flora of the estuaries of Shatt al-Arab have been published since 1973 (Hirano, 1973; Saad & Kell, 1975; Kell & Saad, 1975; Huq *et al.* 1978; Kell, 1978; Saad & Samir, 1978; Al Saadi *et al.*., 1979; Pankow & Huq, 1979; Pankow *et al.*. 1979; Maulood *et al.*, 1981; Islam, 1985). Beside here mentioned studies on algae there are some others from rice fields of north-eastern Iraq (Al-Kaisi, 1976) as well as on diatoms from thermal springs of Iraqi Kardistan (Maulood & Hinton, 1979).

Searching through the literature the authors found that algae of Iraq had been studied from floristic and rarely taxonomic aspect with remarks on ecological conditions. These data relate mainly to *Bacillariophyta*. *Cyanophyta* and less to *Euglenophyta*. *Pyrrophyta*, *Rhodophyta* and *Chrysophyceae*. The majority of species that have been recorded are new not only for Iraq but even for the region of Near East.

With exception of Al Kaisi (1976) who reported *Chara formosa* Rob., *Nitella tenuissima* (Desv.) Kütz. and *Nitella* sp. from rice field (pH 6.8-8.4), charophytes of Iraq had not been studied.

Results of investigations of charophytes collected in the region of the ancient Babylon are summarized in this paper.

MATERIAL AND METHODS

Tests from three localities of charophytes (channel and two muds) in the region of the ancient Babylon have been taken in the period from May to June, 1972. City of Babylon is situated in the south of Mesopotamia, today's Iraq, in so-called lowlands of Babylon, at the altitude less than 100 m. The Tigris and the Euphrates are flowing slowly through the wide plain making numerous meanders, marshes and stable bogs and muds. These stable muds which remain during the whole year inspite of extremely high summer temperatures of 49°C even of 55°C, are probably connected with the river Euphrates.

Records of the water and air temperatures as well as pH values of the water are taken, while collected specimens are fixed in 4% formaldehide in the field.

For the purpose of identification a part of collected material was treated by 5% solution of hydrochloric acid (HCl). In process of species determination and geographical distribution the authors consulted literature data given by Migula (1897), Corillion (1957, 1975), Vodenicarov (1963), Dambska (1964), Wood & Imahori (1964, 1965), Blazencic & Cvijan (1980),Comelles (1982), Blazencic & Blazencic (1983a and b, 1986, 1989), Blazencic *et al.* (1990), Gollerbah & Krasavina (1983), Moore (1986).

Microphotographs are made by binocular lens "Zeiss" (J. Blaz.) and by microscope "Amplival" supplied by additional instrument "Mattik" for automatical recording (D. Temn.).

This collection of Charophytes sampled in Iraq by D. Temniskova is kept in Department of Botany, Biological Faculty, University of Sofia "Kliment Ohridski".

DESCRIPTION OF LOCALITIES

1. The **"Hole"**. This locality placed in the middle of the ruins of the ancient Babylon is filled up with transparent, clear and relatively cold water. Along three sides the Hole is enclosed by the 7.5m high wall, made of bricks, which protrudes 1 m above the sands. Forth side of the wall round the well is partly destroyed and from that place it is possible, with difficulty and by rope, to descend inside the Hole and reach the water surface which dimensions are about 2 x 1-1.5 meters.

Anyway this habitat might be a part of one of the channels in complex hydrosystem of the ancient Babylon. That is therefore an explanation where the clear and cold water is coming from. The bottom of the Hole is covered by authentic remains of babylonian bricks.

Almost entire free water area is covered with Charophytes associated with *Callitriche verna* L., *Mougeotia* sp., *Tribonema* sp. and the others. During July it partly dries up. Temperature of water moves between 20° and 25°C while pH values between 6.5 and 7.5 from May to October.

Dates	Hours	Temperature of water	pH
29th May	6.15 p.m.	21°C	7.5
9th June	11.00 a.m.	23°C	7.5
26th July	7.30 p.m.	25°C	7
21st August	6.45 a.m.	24°C	7.5
12th September	5.00 p.m.	22°C	7
17th October	11.30 a.m.	20°C	6.5

2. **"Little Mud"**. Site by the name of Little Mud is located beside Babylonian lion. Its surface is almost overgrown by reed (*Phragmites* sp.) up to 3.5-4 m above the water. Free water area is covered by duckweed (*Lemna* sp.).

Little Mud is 12-14 m long and about 5-6 m wide. The bottom is muddy. From May to October temperature of water fluctuates between 22°C and 29,5°C, while pH values move from 7 to 8. Records are taken from two places in *Phragmites* area:

Dates	Hours	Temperature of water	pH
9th June	10.00 a.m.	28°C	7.5-7.6
26th July	6.00 p.m.	29.5°C	8.0
21st August	6.00 p.m.	29°C	7.6
17th October	11.00 a.m.	22°C	7.0

3. **"Big Mud".** It is placed between sandy hills near by Zykkurat. Anyway, there is an island in the middle of its large free water area. The bottom is muddy and sandy. Litoral area is overgrown by reed (*Phragmites* sp.). In the period from July to the beginning of November the Big Mud partly dries up. Charophytes grow here in association with *Spirogyra* sp., *Tribonema* sp. and a lot of various diatoms and other algae. Water temperature fluctuates from 21.5°C to 29.0°C from May to October while pH values move into a range of between 7.5 and 8.5. Samples are collected from three places.

Dates	Hours	Temperature of water	pH
31st May	6.00 p.m.	29.0°C	8.0
19th June	6.00 p.m.	29.0°C	7.5
26th July	7.00 p.m.	28.0°C	8.0
21st August	7.00 p.m.	29.0°C	8.4
12th September	6.30 p.m.	26.5°C	8.3
17th October	10.00 a.m.	21.5°C	8.5

SYSTEMATIC ENUMERATION

In material collected in Babylon three genera (*Nitella*, *Tolypella* and *Chara*) with five species (*Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *Chara gymnophylla* A. Br. and *Chara contraria* A. Br. ex Kütz) are identified. Morphological description, size of oogonia, antheridia and oospores beside the data on habitat, water temperature and pH reaction of the water as well as on geographical distribution are given for each of the species.

Nitella opaca Agardh, 1824 (Fig. 1)

Chara opaca Bruzelins, p. 23, 1824 (= var. *flexilis*); *Nitella syncarpa* var. *opaca* (Bruz.) Kützing, p. 256, 1854 (= var. *flexilis*); *Nitella flexilis* var. *flexilis* Wood, p. 15, 1962.

Plants lightly encrusted, dark green. Branchlets 6-7 in a whorl. Only male samples are found. Antheridium 504-542 μm in diameter.

Species has been recorded only in the Big Mud growing from May to November in the water with pH between 7.5 and 8.5 and temperatures from 21.5°C to 29°C.

Geographical distribution: It is wide spread and common on the Earth between latitudes 65°N and 30°S.

Tolypella glomerata (Desv. in Lois.) Leonhardi, 1863 (Figs 2-4)

Chara glomerata Desvaux *in* Loiseleur-Deslongchamps, p. 135, 1810 (= var. *glomerata*); *Tolypella glomerata* (Desv. in Lois) Leonhardi, p. 129, 1863

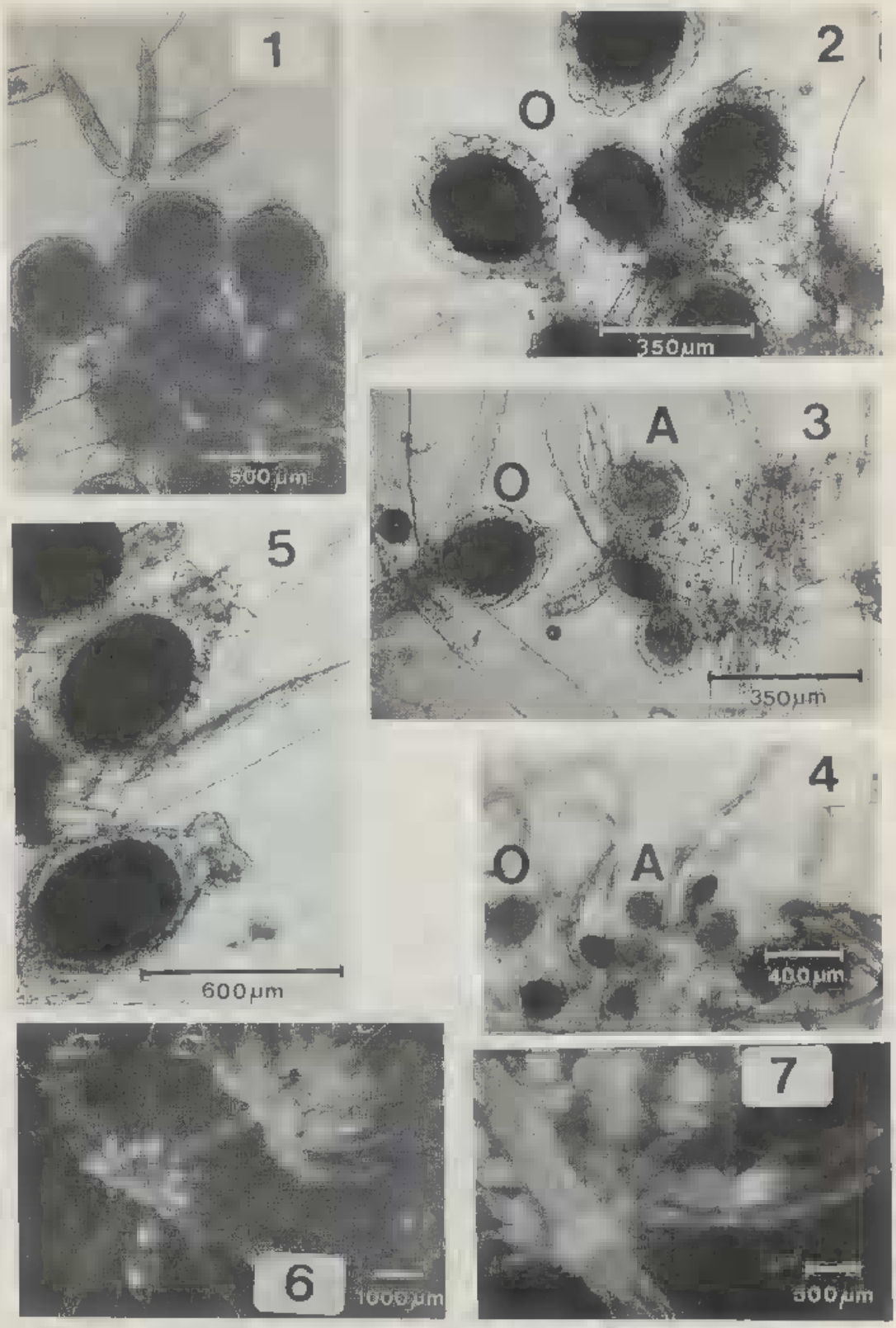

Fig. 1: *Nitella opaca* Ag., axial node with fertile branchlets. - Figs 2-4: *Tolypella glomerata* (Desv. in Lois) Leonh., branchlet node bearing mature and immature oogonia (O) and antheridium (A). - Figs 5-7: *Chara gymnophylla* A. Br. Fig. 5. Branchlet node bearing oogonia (O). Fig. 6. Terminal part of the plant. Fig. 7. Axial node with ecorticate fertile branchlets.

(= var. *glomerata*); *Tolypella nidifica* var. *glomerata* (Desv. in Lois.) Wood, p. 23, 1962.

Small plant up to 5-6 cm high, green, heavily encrusted. Structure of main axes, branches and branchlets typical. Branchlets 6 in a whorl. Gametangia conjoined at branchlets nodes. Oogonia 314-351 μm in diameter and 333.4-426.0 μm long (without coronula). Spiral-cells form 9-10 convolutions. Coronula up to 37.0 μm long and 55.6-74.1 μm in diameter. It is 30 μm longer than it is mentioned in literature. Oospores elliptic, brownish-yellow, up to 277.8 μm in diameter.

Tolypella glomerata has been recorded in both the Little Mud and the Big Mud associated with *Ch. vulgaris*, *Ch. contraria* and *Ch. gymnophylla*. It develops in the period from May to November when temperature of water moves from 21.5° to 29.5°C and pH from 7 to 8.5.

Geographical distribution: As the other algae in Babylon it is also widely distributed but not very frequent. It appears to be cosmopolitan.

Chara vulgaris L. (Fig. 8)

Chara vulgaris Linnaeus, p. 1156, 1753 (= var. *vulgaris*); *Chara foetida* Braun, p. 354, 1834 (= var. *vulgaris*); *Chara vulgaris* var. *vulgaris* et f. *vulgaris* Wood, p. 73, 1965.

Plants up to 15 cm, green, lightly encrusted. Axes up to 525 μm in diameter. Internodes 2-3 times as long as branchlets. Cortex regularly diplostichous. Spine-cells solitary, globular or short-cylindrical. Stipulodes typically developed. Branchlets 8-9 in a whorl, 5-12 mm long, of 3-5 segments of which the ultimate one is ecorticate and 2-3-celled. Branchlet node with 7 bracteoles of which 4 adaxial well developed, 2.5-4 times as long as oogonia while 3 abaxial rudimentary, globose or short-cylindrical, 104-133 μm long. Gametangia at the 3-4 lowest branchlet nodes. Oogonia ellipsoid-cylindrical, 463.2-571.2 μm long (without coronula) and 285.6-370.4 μm in diameter, with 13 convolutions. Coronula 74.1-123.7 μm long and 138.2-171.3 μm wide at the base. Antheridia 314.8-333.4 μm in diameter. Oospores have not been observed.

The plant is recorded in all three habitats. Among all charophytes only *Chara vulgaris* was found to grow in the Hole where it developed in considerable density. Also, it is reported frequently as appearing in the Big Mud. Plants sampled in the Little Mud are heavily encrusted, with long branchlets and often long ecorticate terminal segment and bracteoles longer than usual, all due to low light intensity existing in habitat Little Mud where this species are growing among reed.

It develops from May to November at the water temperatures of between 20° and 29°C and pH of 6.5-8.5.

Geographical distribution: Being cosmopolitan it appears throughout the world between the latitudes 70°N and 50°S.

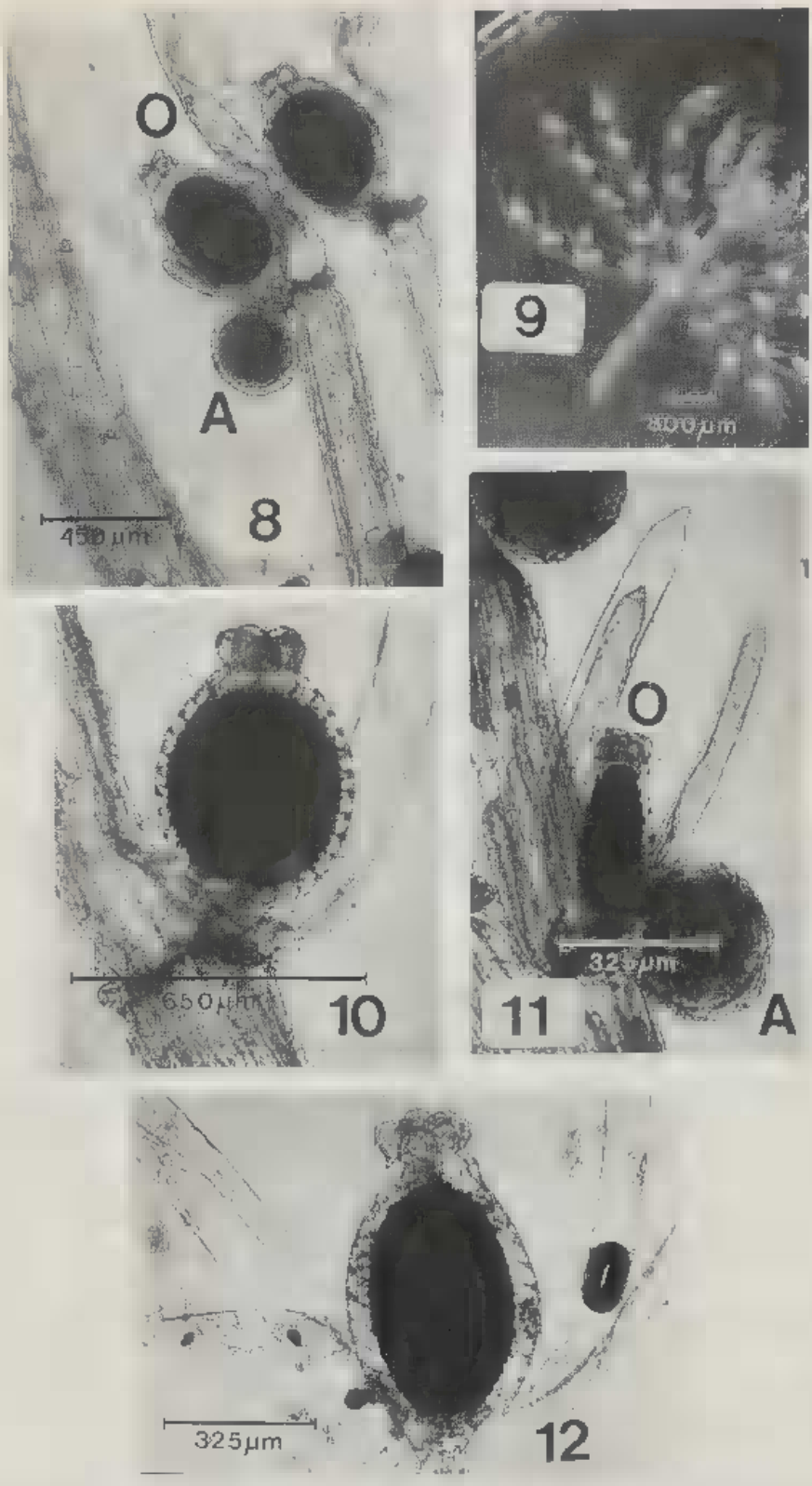

Fig. 8: *Chara vulgaris* L., branchlet node with oogonia and antheridium. - Figs 9-12: *Chara contraria* A. Br. ex Kütz. Fig. 9. Terminal part of the plant. Fig. 10 and 12. Branchlet nodes bearing mature oogonia. Fig. 11. Immature oogonium (O).

***Chara gymnophylla* A. Br.** (Figs 5-7)

Chara foetida var. *gymnophylla* Braun, p. 354, 1834; *Chara vulgaris* f. *gymnophylla* (A.Br.) Hy, p. 240, 1914; *Chara vulgaris* var. *gymnophylla* f. *gymnophylla* Wood, p. 8, 1962.

Plants up to 12 cm high, lightly encrusted, green. Main axes and branches flexible, about 0.5 mm wide. The longest internodes 2-4 times as long as branchlets. Cortex structure, spine-cells and spinulodes typically developed. Branchlets 9 up to 2 cm long, delicate, ecorticate or 1-2 of the lowest segments may be corticate. Bracteoles 7 of which adaxials even 9-10 times as long as oogonium. Gametangia conjoined at the first lowest branchlet node. Oogonia ellipsoid, 481.5-555.6 μm long (without coronula) and 14.4-361.6 μm in diameter with 12-13 convolutions. Coronula 92.6-111.1 μm long and 129.6-161.8 μm wide at the base. Oospores have not been recorded. Antheridia 295-351.9 μm in diameter.

This species have been found in both localities the Little Mud and the Big Mud although less present than the others. It develops at the water temperatures ranged from 21.5° to 29.5°C and pH levels of between 7 and 8.5 from May to November.

Geographical distribution: It is recorded in Europe, Africa and Asia.

***Chara contraria* A. Br. ex Kütz. (Figs 9-12)**

Chara contraria subsp. *contraria* (A. Br. ex Kütz.) Braun, p. 788, 1867 (= f. *contraria*): *Chara foetida* var. *contraria* (A. Br. ex Kütz.) Cosson et Germain, pl. 41, 1882 (= var. *vulgaris*); *Chara vulgaris* var. *vulgaris* f. *contraria* (A. Br. ex Kütz.) Wood, p. 73, 1965.

Plants up to 19.5 cm high and 371-761 μm in diameter, bright-green and moderately encrusted. The longest internodes 2-2.5 times as long as branchlets. Cortex, spine-cells and stipulodes, both tiers, typically developed. Branchlets 7-9, 1.2-1.7 cm long, of 3-5 segments corticate and terminal one up to 0.36 cm long, ecorticate and 3-celled. Bracteoles 7 of which 4 adaxial 3-5 times as long as oogonia. Gametangia mostly at the 3 lowest branchlet nodes. Oogonia 523.6-648.2 μm long (without coronula) and 370.4-447.5 μm in diameter. Convolutions 12-13. Coronula 74-92.6 μm long and 142.8-185.2 μm in diameter at the base. Oospores ellipsoid, up to 518.6 μm long and 314.8-333.4 μm wide. Antheridia vary from 351.9 to 447.5 μm in diameter.

Chara contraria is found in both the Little Mud and the Big Mud. Samples collected from Little Mud seem to be more encrusted than those from Big Mud where species develops in considerable density. It grows between between May and November at water temperatuers ranged from 21° to 29°C and pH between 7.5 and 8.5.

Geographical distribution: Widespread species as *Chara vulgaris*.

DISCUSSION

Morphological characteristics. Comparative analysis of literature data and authors' observations points out certain but insignificant differences that are in a range of expected individual variations (Migula, 1897; Dambska, 1964; Wood & Imahori, 1964, 1965; Corillion, 1975; Gollerbach & Krasavina, 1983).

In connection with status of species *Chara gymnophylla* it has been long debated through the literature in attempt to define it more precisely, remaining actual even nowadays. Morphological observations of differential taxonomic characters in species *Chara gymnophylla* and *Chara vulgaris* sampled in Babylon show the greatest degree of morphological variation such as different degree of branchlets cortication: there are examples with quite ecorticate branchlets bearing gametangia, up to those which 1 or 2 segments are corticated. All these combinations can be found on the same individual, even on the branchlets of the same whorl.

However, this appearance points out the evidence, the most acceptable among the modern authors, that *Chara gymnophylla* might be regarded as subspecies within species complex of *Chara vulgaris* (Corillion, 1975) which different morphological characteristics appear mostly to be induced by ecological conditions such as water temperature, pH reaction of the water, etc.

Geographical distribution. All species identified in Babylon appear to be cosmopolitan in distribution. They are recorded almost all over the continents including Asia but, as the authors could find concerning the literature, are not mentioned in Iraqi flora.

Ecological observations. Locality called the Hole is a sort of well which differs from the other two investigated localities by its physical characteristics as well as by the presence of *Chara vulgaris*, the only of charophytes that grows here. Other two localities are the bogs where the mentioned species are growing with exception of *Nitella opaca* which grows only in the Big Mud close to the river Euphrates. The fact that *Nitella opaca* tends to develop only in the stable streaming water suggests that the Big Mud is connected with the Euphrates by the channels of the ancient hydrosystem or could be supplied by the underground water.

As it appears to tolerate low light intensity (Migula, 1897) *Nitella opaca* grows in the shaded places of the Big Mud, in the zone of reed (*Phragmites* sp.), at the depths of 0.5-0.7 m, making the lowest plant layer together with *Chara contraria* which higher thallus reaches the water surface.

Comparing literature data on water temperature and pH values with their own observations in Babylon, the authors have made following conclusion. Five species of charophytes investigated in Babylon develop at the water temperature of between 20° and 29°C. During the months of June, July and August water temperatures were found to vary about 28-29.5°C. Otherwise, high water temperatures which reach 30°C were noticed in literature only for *Chara vulgaris* and *Chara gymnophylla* (Corillion, 1957).

Consulting literature the authors found *Chara vulgaris* to tolerate pH range of 7-8.5 (Corillion, 1957, 1975). Meanwhile, searching the locality "Hole" in Babylon, the authors discovered this species to grow in considerable density in the water with pH ranged from 6.5 to 8.5 showing thus more tolerance towards pH reaction of the water than it is reported in literature. It is also recorded pH values 7-8 for *Chara contraria*, 7.3-7.8 for *Chara gymnophylla* as well as 7-7.8 for *Tolypella glomerata* (Corillion, 1957, 1975) while the authors found these species in Babylon to grow in water with pH from 7 to 8.5 showing thus to be able to tolerate higher pH values than it is recorded in literature. As it is known from literature *Nitella opaca* tolerates pH values ranged between 6.3 and 7.5 (Corillion, 1957, 1975). Stroede (1931) found it to grow under the conditions of pH values of about 6 (5.16-6.3 precisely) while Höll (1928) mentioned pH 7.63 as the highest level for this species (quoted from Stroede, 1931). Blazencic & Blazencic (1983, 1986, 1989) registered several localities in Yugoslavia with pH 7-8. It means that *Nitella opaca* can tolerate wider range of pH values than it was considered before.

On the whole, according to the new evidence reported from Babylon, it can be concluded that *Chara contraria*, *Nitella opaca* and *Tolypella glomerata* appear to tolerate higher water temperatures than it was known. Besides, all mentioned species seem to be more tolerant towards more alkaline water (7-8.5) whereas the range of pH tolerance in *Nitella opaca* appears to be the widest.

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